

We claim:

1 1. A method for designing an alternating phase shifting mask  
2 (altPSM) for projecting an image on an image plane, the method  
3 comprising:  
4 providing a circuit layout;  
5 identifying a critical element of said circuit layout, said  
6 critical element having a layout dimension (LW), said layout  
7 dimension corresponding to a target image dimension in the image  
8 plane;  
9 providing a relationship between phase shape width and said  
10 target image dimension;  
11 selecting an optimal phase shape width so that said  
12 relationship has an optimal value; and  
13 generating a phase shape disposed adjacent to said layout  
14 dimension wherein said phase shape has said optimal phase shape  
15 width.

1 2. The method of claim 1 wherein said relationship comprises  
2 across-chip line width variation (ACLV), and said selecting further  
3 comprises minimizing said ACLV.

1 3. The method of claim 2 wherein said providing a relationship  
2 further comprises providing at least one distribution of process  
3 errors in at least one lithographic parameter and computing a set  
4 of ACLV realizations for said target image dimension and computing  
5 the standard deviation of said ACLV realizations for said target  
6 image dimension.

1 4. The method of claim 3 wherein said at least one lithographic  
2 parameter is selected from the group consisting of dose, focus,  
3 lens aberration, mask critical dimension error, transmission error,

4 phase error, mask manufacturability error, and a combination  
5 thereof.

1 5. The method of claim 4 wherein said at least one distribution  
2 comprises a gaussian distribution.

1 6. The method of claim 1 wherein said relationship comprises  
2 process window, and said selecting further comprises maximizing  
3 said process window.

1 7. The method of claim 1 wherein said providing a relationship  
2 comprises providing a lookup table having optimal phase shape  
3 widths for a range of target image dimensions stored therein.

1 8. The method of claim 1 wherein said relationship comprises a  
2 requirement that said optimal phase shape width be about  $0.8-1.2 \times$   
3 LW.

1 9. A computer program product comprising a computer readable  
2 storage medium having stored therein instructions executable by the  
3 computer for performing a method for designing an alternating phase  
4 shifting mask (altPSM) for projecting an image on an image plane,  
5 the method comprising:

6 providing a circuit layout;

7 identifying a critical element of said circuit layout, said  
8 critical element having a layout dimension (LW), said layout  
9 dimension corresponding to a target image dimension in the image  
10 plane;

11 providing a relationship between phase shape width and said  
12 target image dimension;

13 selecting an optimal phase shape width so that said  
14 relationship has an optimal value; and

15       generating a phase shape disposed adjacent to said layout  
16 dimension wherein said phase shape has said optimal phase shape  
17 width.

1 10. The computer program product of claim 9 wherein said  
2 relationship comprises across-chip line width variation (ACLV), and  
3 said selecting further comprises minimizing said ACLV.

1 11. The computer program product of claim 10 wherein said providing  
2 a relationship further comprises providing at least one  
3 distribution of process errors in at least one lithographic  
4 parameter and computing a set of ACLV realizations for said target  
5 image dimension and computing the standard deviation of said ACLV  
6 realizations for said target image dimension.

1 12. The computer program product of claim 11 wherein said at least  
2 one lithographic parameter is selected from the group consisting of  
3 dose, focus, lens aberration, mask critical dimension error,  
4 transmission error, phase error, mask manufacturability error, and  
5 a combination thereof.

1 13. The computer program product of claim 12 wherein said at least  
2 one distribution comprises a gaussian distribution.

1 14. The computer program product of claim 9 wherein said  
2 relationship comprises process window, and said selecting further  
3 comprises maximizing said process window.

1 15. The computer program product of claim 9 wherein said providing  
2 a relationship comprises providing a lookup table having optimal  
3 phase shape widths for a range of target image dimensions stored  
4 therein.

1 16. The computer program product of claim 9 wherein said  
2 relationship comprises a requirement that said optimal phase shape  
3 width be about  $0.8-1.2 \times LW$ .

1 17. An alternating phase shifting mask for projecting an image on  
2 an image plane, the mask comprising:

3 a layout pattern having at least one element having a layout  
4 dimension, said layout dimension corresponding to a target image  
5 dimension in the image plane;

6 a phase shape having a phase width, wherein said phase shape  
7 is disposed adjacent to said layout dimension, and wherein said  
8 phase width is selected in accordance with a relationship between  
9 said phase width and said target image dimension.

1 18. The mask of claim 17 wherein said relationship comprises  
2 across-chip line width variation (ACLV), and said phase width is  
3 selected so that ACLV is minimized.

1 19. The mask of claim 17 wherein said relationship comprises  
2 process window, and said phase width is selected so that said  
3 process window is maximized.

1 20. The mask of claim 17 wherein said phase width is about  $0.8-1.2$   
2 times said layout dimension.